City of Austin
WATERSHED PROTECTION

Impacts of City of Burnet draft wastewater discharge permit on Hamilton Creek and Lake Travis

Chris Herrington, PE
City of Austin
Watershed Protection Department

SR-10-04. April 2010

Abstract

A draft permit has been prepared by the Texas Commission on Environmental Quality(TCEQ) to amend an existing domestic wastewater TPDES discharge permit for the City of Burnet, Texas (WQ0010793002, TX0026484). Burnet currently has a permit to discharge wastewater to Hamilton Creek up to 0.726 million gallons per day with no limit on total phosphorus. Historically, the plant seldom discharges due to operation of irrigation facilities on adjacent Burnet owned property. The final phase of the new permit allows for an annual discharge up to 1.7 million gallons per day with a daily average total phosphorus limit of 0.5 mg/L to Hamilton Creek, approximately 15 miles upstream of the confluence with Lake Travis. A combined SWAT/CE-QUAL-W2 water quality model developed by the Lower Colorado River Authority (LCRA) was used to evaluate the potential water quality impacts of the proposed discharge. The model predicts significant degradation of the receiving creek and the lake under the draft permit versus current "no discharge" conditions.

Introduction

The TCEQ has prepared a draft permit to amend an existing domestic wastewater discharge for the City of Burnet, Texas (WQ0010793002, TX0026484). The final phase of the draft permit allows for an annual average flow of 1.7 million gallons per day (MGD) with a daily average phosphorus limit of 0.5 mg/L and no limit on total nitrogen. The discharge is to Hamilton Creek, approximately 15 miles upstream of the confluence with Lake Travis (segment 1404). Hamilton Creek flows into Lake Travis at the upstream end of the lake near Max Starke Dam.

The City of Burnet has an existing TPDES discharge permit with a annual average flow of 0.726 MGD with no limit on total phosphorus, although the majority of wastewater has been land applied via a 30 TAC Chapter 210 beneficial reuse authorization. Based on discharge monitoring reports available via the U.S. Environmental Protection Agency permit compliance system (EPA-PCS, www.epa.gov/enviro/html/pcs/pcs_query_java.html), Burnet reported a discharge to Hamilton Creek in only 1 month (June 2007) in almost four years (September 2005 to March 2009).

The Colorado River is the sole source of drinking water for the City of Austin, and a new drinking water treatment facility is in construction that will withdraw directly from Lake Travis. Although new or expanded wastewater discharges within 10 miles of Lake Travis are prohibited by 30 TAC Chapter 311, subchapter A, the Burnet facility is upstream of the 10 mile boundary.

The Lower Colorado River Authority (LCRA) has developed a calibrated water quality model (CREMS) for Lake Travis (Anchor QEA/Parsons, 2009), combining a Soil and Water Assessment Tool (SWAT version 2005, Neitsch et al 2005) watershed model with a CE-QUAL-W2 (version 3.5, Cole and Wells 2006) lake model. The LCRA model was used to evaluate the potential water quality impacts of the new draft permit on Hamilton Creek and Lake Travis.

The City of Burnet submitted two QUAL-TX model outputs to TCEQ to support a finding that the water quality in the upper reaches of Lake Travis will be maintained with the proposed permit (Thornhoff Consulting 2009). The inadequacy of the steady-state QUAL-TX model to accurately evaluate nutrient enrichment impacts, particularly when evaluated under a limited number of temperature and flow conditions, has previously been demonstrated (Herrington 2008). TCEQ antidegradation policies for protecting high quality waters from nutrient enrichment are qualitatively defined (TCEQ 2003) so that new discharges may not lower water quality by more than a *de minimus* extent. Neither degradation nor *de minimus* are defined numerically in the Texas Surface Water Quality Standards (30 TAC 307); however, for algae impacts, a change in nutrient and chlorophyll-a concentrations and trophic status have been used as surrogate indicators in at least one permit hearing (SOAH, 2008)

Methods

The LCRA CREMS model was used to evaluate the potential water quality impacts of the Burnet wastewater discharge based on the draft final phase daily effluent limits. Interim phase effluent limits are substantially higher, but effectively represent the existing TPDES permit limits. The impact of the fully utilized current permit was also modeled, although actual discharges to Hamilton Creek under the current permit are rare as the majority of wastewater is reused under a 30 TAC 210 beneficial reuse authorization. This scenario is designated throughout this report as "current permit".

The Burnet discharge was included in the SWAT watershed model as a point source. A "no discharge" scenario was run with no wastewater discharge (all permit limits set to zero) to represent current conditions. The final draft permit limits were used to evaluate the "worst case" or full permitted discharge scenario. Effluent quality for modeled constituents was derived from the permit, the Burnet modeling report (Thornhoff Consulting Engineers 2009), and previous wastewater modeling exercises (Table 1) and entered as annual averages.

Table 1. Effluent limits for Burnet discharge included in model.

Scenario	Flow (MGD)	Phosphorus (mg/L)	Organic Nitrogen (mg/L	Nitrate (mg/L)	Ammonia (mg/L)	Dissolved Oxygen	$cBOD_5$ (mg/L)
Current Conditions (no discharge)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Current Permit	0.726	2.37	1.0	18.0	3.0	5.0	10.0
Draft Permit	1.7	0.5	1.0	18.0	2.0	5.0	5.0

SWAT output from segment 5 of the watershed model was used to generate the revised input files for lake segment 6 of the CE-QUAL-W2 model, following the methods detailed in the CREMS model report (Anchor QEA/Parsons 2009). Change in nutrient loadings and concentrations at the

mouth of Hamilton Creek were evaluated from SWAT output. Change in annual average chlorophyll-a concentrations and summer averages (calculated from June to September) were evaluated from the CE-QUAL-W2 lake model output. Models were run for the 1984 to 2006 time period.

Results

Comparison of the current condition "no discharge" versus full permit scenario SWAT predicted flows indicates that Hamilton Creek at the confluence with Lake Travis would change from an intermittent creek, predicted to be dry approximately 19% of the period of record (1984-2006), to a perennial creek (no predicted zero flow days) under the draft permit or the current permit (271 predicted no flow days, or approximately 3% of the period of record). Daily total nitrogen and total phosphorus loads from Hamilton Creek to Lake Travis at the confluence are predicted to increase on average more than 68 times and 23 times, respectively under the new draft permit versus current "no discharge" conditions. Over the modeling period of record, the draft permit represents a reduction in phosphorus loads of 6% and an increase in nitrogen load of 59% versus the current TPDES permit.

Concentrations of nutrients at the mouth of Hamilton Creek are shown in comparison to TCEQ screening levels for freshwater streams (TCEQ 2008) (Table 2). Median nitrate-nitrogen concentrations are predicted to be more than 6 times higher than the TCEQ screening level when comparing the draft permit to current "no discharge" conditions. Note that the entire length of Hamilton Creek is predicted to yield nitrate-nitrogen concentrations above the human health drinking water standard of 10 mg/L for approximately 55% of the year for the draft permit versus current "no discharge" conditions. It is unknown if there are any drinking water withdrawals directly from Hamilton Creek. The draft permit versus the current permit indicates that median phosphorus concentrations from the discharge will decrease, while nitrogen concentrations will increase. In comparison to the TCEQ screening levels, the current permit should not have been granted based on predicted degradation in nitrogen concentrations in Hamilton Creek and substantial increases in phosphorus. Under the current permit, phosphorus concentrations at the mouth of Hamilton Creek would exceed TCEQ screening levels more than 36% of the time and Hamilton Creek would be "of concern" for phosphorus based on TCEQ current assessment procedures (TCEQ 2008).

Table 2. Predicted median concentrations of nutrients at the mouth of Hamilton Creek, with TCEQ screening levels (TCEQ 2008).

Conc. in mg/L	Current Permit	Draft Permit	Current "no discharge" Conditions	TCEQ Screening Level
Nitrate	5.941	12.037	0.681	1.95
Ammonia	0.012	0.023	0.010	0.33
Total Nitrogen	6.551	12.697	0.923	n/a
Total Phosphorus	0.449	0.287	0.035	0.69

Concentrations of total nitrogen and total phosphorus can be used to infer stream trophic status (Table 3, Dodds et al 1998). Based on the nitrogen/phosphorus ratios (Redfield 1958), algae in Hamilton Creek are likely to be phosphorus-limited under either the current permit or new draft permit evaluation scenarios. Predicted median total phosphorus concentrations at the mouth of Hamilton Creek indicate a change from a typically low mesotrophic state to an enriched, eutrophic state under the draft permit versus current "no discharge" conditions. Comparison of

the current permit versus the new draft permit predicts that Hamilton Creek will be slightly more mesotrophic (5.2% of the time under the current permit versus 13.2% of the time under the draft permit), although both scenarios predict (more than 84% of the time) Hamilton Creek will be primarily eutrophic. Either the current permit or the new draft permit would significantly alter the trophic status of Hamilton Creek, degrading the creek from a low mesotrophic state to an enriched eutrophic state for the majority of the year.

Table 3. Stream trophic status boundaries based on ambient concentrations of total nitrogen and total phosphorus (Dodds et al 1998).

Conc. in mg/L	**Oligotrophic/ Mesotrophic Boundary**	**Mesotrophic/ Eutrophic Boundary**
Total Nitrogen as N	0.7	1.5
Total Phosphorus	0.025	0.075

Under either the current permit or the new draft permit versus current "no discharge" conditions, the Burnet discharge is predicted to increase the median concentrations of nutrients in Lake Travis at the confluence with Hamilton Creek (Table 4). The draft permit is predicted to increase the median concentration of nitrogen in Lake Travis, and slightly reduce the concentration of phosphorus versus the current TPDES permit. Increases in predicted daily chlorophyll-α concentrations in Lake Travis at Hamilton Creek are substantial in critical time periods when comparing the draft permit versus current "no discharge" conditions (Figure 1), and measurable increases in chlorophyll-α concentrations are predicted even at the most downstream end of Lake Travis near Mansfield Dam.

Maximum increases of chlorophyll-α from the discharge in Lake Travis are typically predicted to occur in the summer months. Over the 22 year simulation period (excluding 4 dry years with less than 122 summer days in model output), summer mean chlorophyll-α concentrations in Lake Travis at the confluence with Hamilton Creek are predicted to increase by more than 15% with either the current or new draft permit versus existing "no discharge" conditions, with a maximum summer mean increase of 45.6%. There is a 0.7% increase in predicted summer mean chlorophyll-α concentrations in Lake Travis at Hamilton Creek with the new draft permit versus the current TPDES permit. Three summer means in Lake Travis at Hamilton Creek are predicted to shift from a mesotrophic state (4-10 µg/L) to a eutrophic state (>10 µg/L) in the simulation period under the draft permit versus current "no discharge" conditions. An additional 353 days are predicted in which Lake Travis would be eutrophic at Hamilton Creek during the simulation period under the draft permit versus the current "no discharge" conditions. Increases in annual average summer chlorophyll-a concentrations will be evident throughout Lake Travis from Hamilton Creek confluence to the downstream Mansfield Dam (Figure 2) under the new draft permit versus current "no discharge" conditions.

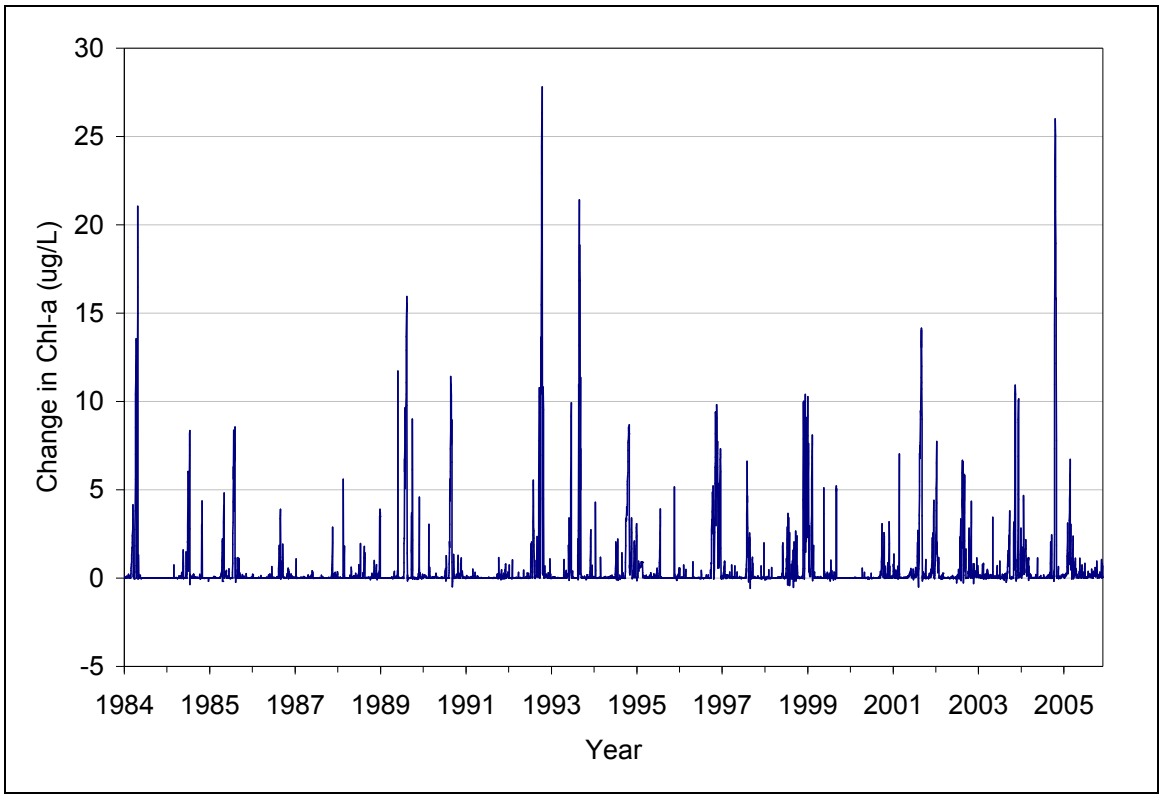

Figure 1. Predicted change in daily chlorophyll-α concentrations from current "no discharge" conditions under the draft permit in Lake Travis at Hamilton Creek (µg/L chl-α).

Table 4. Predicted median concentrations of nutrients in Lake Travis at Hamilton Creek.

Conc. in mg/L	Draft Permit	Current Permit	Current "no discharge" Conditions	TCEQ Screening Levels
Nitrate	0.279	0.191	0.095	0.37
Total Nitrogen	0.727	0.620	0.531	n/a
Total Phosphorus	0.023	0.025	0.019	0.20

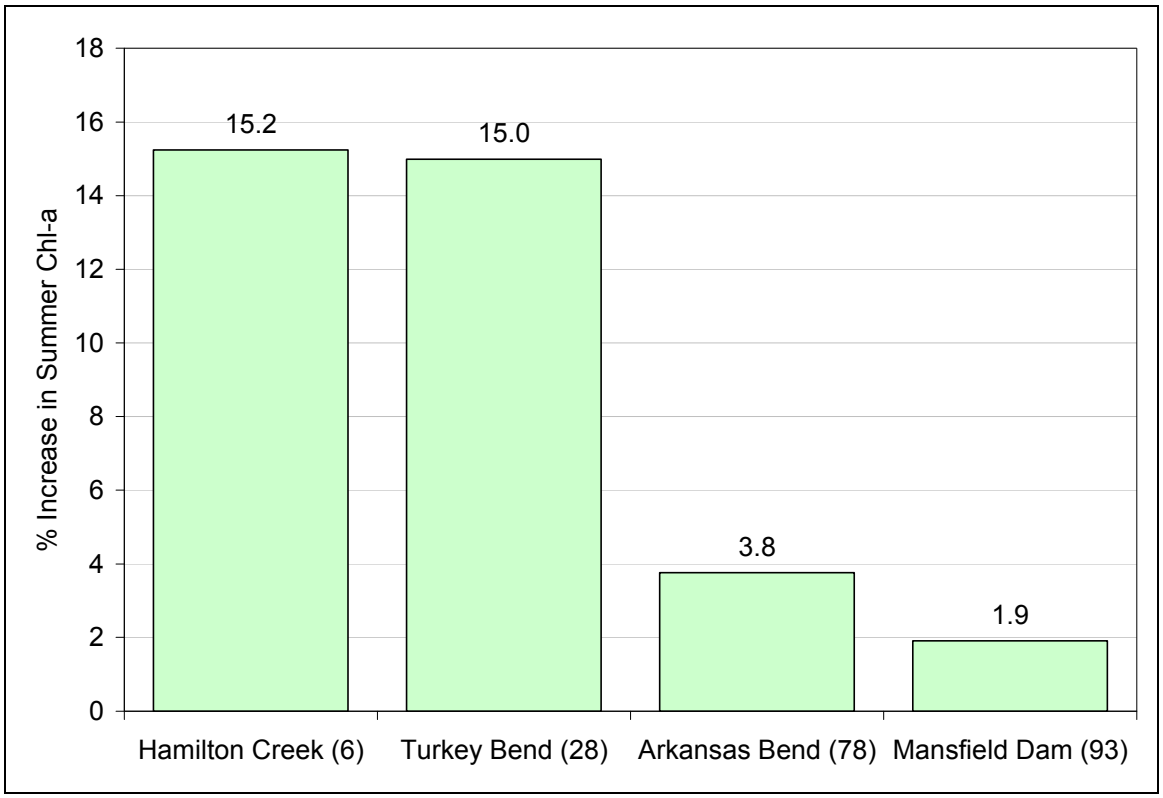

Figure 2. Percent increase in annual average summer (June-September) chlorophyll-α concentrations with new draft permit versus current "no discharge" conditions at selected locations in Lake Travis.

Conclusions

The predicted increases in nutrient loading to Hamilton Creek at the confluence with Lake Travis, more than 15 miles downstream of the Burnet discharge point, and in-stream concentrations resulting from the draft permit represent more than *de minimus* degradation of the water quality of Hamilton Creek versus current "no discharge" conditions. Due to the resulting increase in predicted chlorophyll-α concentrations in Lake Travis versus current "no discharge" conditions, the draft permit represents more than *de minimus* degradation of the water quality of Lake Travis. The draft permit will increase the predicted concentrations of nutrients in Hamilton Creek and increase the concentration of nitrogen in Lake Travis versus the current TPDES permit.

Discussion

More stringent effluent limits or reductions of flow thru continuation or expansion of the existing land application method could reduce the degradation of the creek and the lake from the Burnet wastewater discharge. These restrictions should be written into the permit; otherwise, the full discharge amount must be used in evaluating the current draft. Based on the current modeling results, not available to TCEQ at the time the existing Burnet TPDES permit was issued, the current Burnet TPDES permit should not have been issued as it results in more than a *de minimus* degradation of the water quality of Hamilton Creek and Lake Travis. As Burnet has responsibly chosen to operate their existing facility as primarily a "no discharge" facility, the evaluation of the new draft permit should be conducted considering the current, "no discharge" water quality conditions. Because the current permit is effectively not being used, evaluation of the proposed draft permit versus the current permit limitations, is not in keeping with the spirit of anti-degradation, anti-backsliding environmental regulations. TCEQ is required under 30 TAC §311.5

to protect and maintain the existing water quality of Lake Travis, and thus any proposed permit actions must be considered against this standard and evaluated against the current water quality of the lake.

Because of the regional importance of Lake Travis as a drinking water supply and recreational resource, the cumulative impacts of multiple wastewater discharges to the lake must always be considered. Cumulative impacts could potentially be mitigated by insuring that no single discharge may significantly impact the lake at the edge of the mixing zone where the effluent enters the lake.

Acknowledgements

This report would not be possible without the assistance of Martha Turner, PE, and Aaron Richter, EIT, of the City of Austin Watershed Protection Department. The City of Austin would also like to express thanks to the Lower Colorado River Authority and it's consultants for their cooperation in providing the CREMS model for use.

References

Anchor QEA, LLC, and Parsons Water and Infrastructure, Inc. 2009. Colorado River Environmental Models, Phase 2: Lake Travis. Prepared for the Lower Colorado River Authority.

Cole, T.M., and S.A. Wells. 2006. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged,Hydrodynamic and Water Quality Model, Version 3.5. United States Army Corps of Engineers (USACE). Draft Instruction Report EL-06-1.

Dodds, W.K., J.R. Jones, and E.B. Welch. 1998. Suggested Classification of Stream Trophic State: Distribution of Temperate Stream Types by Chlorophyll, total Nitrogen and Phosphorus. Water Resources 32(5): 1455-1462.

Herrington, C. 2008. Extension of an LA-QUAL (version 8.0) model for the proposed HCWID#1 wastewater discharge to realistic Bear Creek temperature and flow conditions. City of Austin Watershed Protection and Development Review Department. SR-08-04.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. Soil and Water Assessment Tool Theoretical Documentation: Version 2005. USDA Agricultural Research Center and Texas A&M University Agricultural Experiment Station.

Redfield, A. 1958. The biological control of chemical factors in the environment. American Scientist 46: 205-221.

State Office of Hearings Examiner. SOAH Docket No. 582-08-0202; TCEQ Docket No. 2007-1426-MWD; Proposal for Decision In Application by Hays County Water Control & Improvement District No. 1 for an Amendment to Texas Pollutant Discharge Elimination System Permit (TPDES) Permit No. WQ0014293001, November 19, 2008.

Texas Commission on Environmental Quality (TCEQ). 2003. Procedures to Implement the Texas Surface Water Quality Standards. RG-194.

Texas Commission on Environmental Quality (TCEQ). 2008. DRAFT 2008 Guidance for Assessing and Reporting Surface Water Quality in Texas in compliance with Section

305(b) and 303(d) of the Federal Clean Water Act. Prepared by Surface Water Quality Monitoring Program.

Thornhoff Consulting Engineers, Inc, in association with Michael H. Tomme, LLC. 2009. City of Burnet, Texas, Wastewater Treatment Plant Expansion, Evaluation of Effluent Discharge Upon Lake Travis. August 3, 2009.